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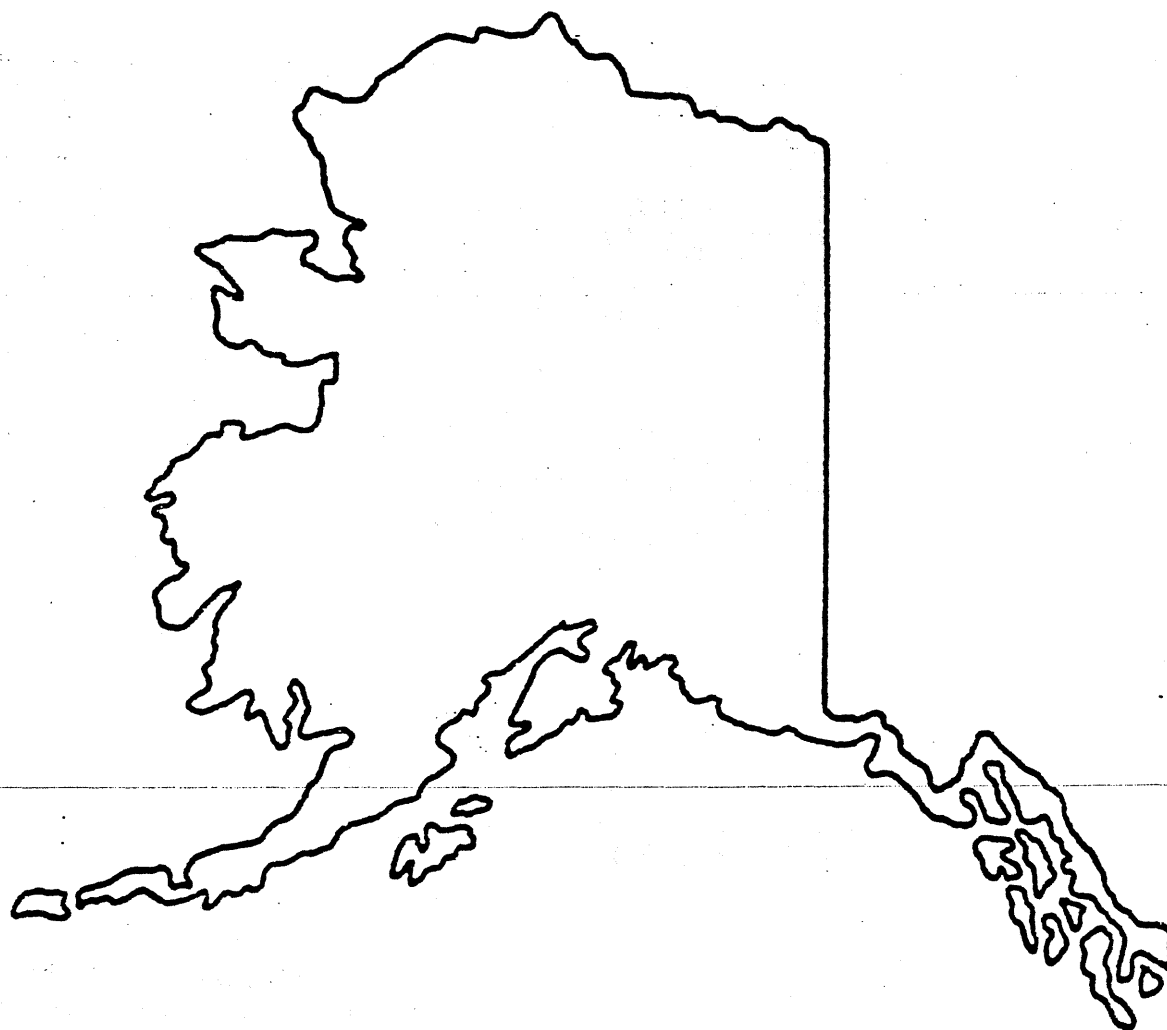


Forest Pest Management Report

BIOLOGICAL EVALUATION R10-90-2

WOUNDING ON RESIDUAL SITKA SPRUCE AND WESTERN HEMLOCK
REMAINING AFTER THINNING ON PRINCE OF WALES ISLAND,
ALASKA

JANUARY 1990



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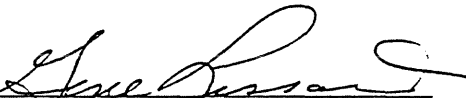
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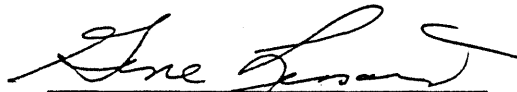


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ABSTRACT

A total of 286 Sitka spruce and western hemlock trees were examined before and after experimental thinning in three young-growth stands (42 to 65 years old) on Prince of Wales Island to determine incidence of wounding from logging activities. Frequency of wounding was similar among the three sites: 61% of spruce and 33% of hemlock had one or more scars. Most wounds (67% for spruce and 82% for hemlock) were located on the lower 16 feet of the bole, although superficial roots and the upper bole of trees were also commonly scarred. Few trees had more than 30% of their bole's circumference wounded, suggesting that outright mortality due to bole scars will be rare. Twenty-six percent of wounds on spruce and 35% wounds on hemlock were larger than 1 ft², the size of wound thought to be necessary for allowing decay fungi to enter boles and initiate internal wood decay. Previous research on decay in wounded trees from areas outside of Alaska and needed research in southeast Alaska are discussed.

INTRODUCTION

Young-growth stands of Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) that result from harvest of old-growth are becoming increasingly common on the Tongass National Forest in southeast Alaska. Extensive clear-cutting in this area did not occur until two major pulp mills began operating in the mid 1950's. Thus, most young-growth stands are less than 35 years old. Some such stands receive precommercial thinning at about age 15 years, but silvicultural techniques for managing these stands and unthinned stands in the mid and later phases of the planned 100-year rotation have not been resolved.

A second thinning with yarding removal of trees may be considered near mid-rotation age (40 to 60 years) for silvicultural reasons. Such thinnings may also be considered for stands that did not receive precommercial thinning. Thinning may also be desirable to enhance wildlife habitat by allowing more light to reach the forest floor. Unthinned stands are often dark and support a poorly developed understory flora. Thinning at mid-rotation has only recently been attempted in southeast Alaska because so few managed stands have reached this stage.

A Second Growth Management Program of USDA Forest Service, Alaska Region evolved to implement and monitor demonstration projects of applied silvicultural treatments in young-growth stands on the Tongass National Forest. Cooperators in the specific demonstration areas on Prince of Wales Island included personnel in the Thorne Bay Ranger District, Ketchikan Area, Regional Office, Forestry Sciences Laboratory, and State and Private Forestry. The objective of the demonstration areas is to provide information on enhancement of wildlife habitat and techniques of thinning.

Forest Pest Management was requested to evaluate logging damage to residual trees that remained after experimental thinnings of three advanced young-growth stands on Prince of Wales Island, Alaska. This report documents those evaluations.

METHODS

Stands of young-growth at three sites located at Naukati, Shaheen, and Gravelly Creek on Prince of Wales Island (Fig. 1) serve as demonstration areas for the Second Growth Management Program (USDA Forest Service 1988) and were selected for study. They were dominated by Sitka spruce and western hemlock, except the Gravelly Creek site had almost entirely spruce. Tree ages ranged 40 to 50 years old. All stands resulted from natural regeneration following the previous logging of old-growth. The stands occurred below 500 ft (150 m) elevation on hillsides with less than 15% slope and had soils belonging to the Ulloa Series of well-drained limestone.

Prior to the experimental thinning, stands were marked to leave a spacing of residual trees that ranged from 18 x 18 ft to 25 x 25 ft after logging. Plots were established throughout stands to allow for monitoring of understory vegetation and condition and growth of residual trees before and after logging. Corridors, 20-ft wide and 30-ft wide, were marked for clearcutting in some locations. Corridors allowed for yarding, but also presented the opportunity for the Second Growth Management Team to evaluate the effect of corridor-cutting on understory and residual trees. Some plots were located in such corridors; residual trees in these plots occurred on corridor edges.

Trees greater than 5 in. dbh located by 20 BAF prism from plot center were selected in plots. Numbers were painted on all selected trees and their distance and azimuth from plot center were recorded. A total of 286 trees (187 spruce and 99 hemlock) on 39 plots were examined. Personnel from Forest Pest Management examined all plot trees for scars prior to logging so that any subsequent wounds could be attributed to the logging activities.

All sites were logged during July 1984. Trees were cable-yarded at all three sites; some tractor yarding occurred at the Gravelly Creek site.

All trees were re-examined in June, 1988. Boles and superficial roots were carefully observed for the presence of wounds. Number of wounds and circumference of bole affected by wounds were recorded for each wounded tree. Data recorded for each wound were height above ground (or occurrence on roots), wound length, wound width, and wound depth (shallow or deeply gouged).

RESULTS AND DISCUSSION

The frequency of wounding was similar for the three sites on Prince of Wales Island; an average of 61% of spruce and 33% of hemlock had one

or more scars as a result of the logging activities (Table 1). Stand treatment (corridor logging vs individual tree thinning had no significant affect on wounding (Table 2).

Some trees had two or more scars (maximum was eight), but few trees had more than 30% of their bole circumference wounded (Fig. 2). Thus, direct mortality of these trees from bole wounding will probably be uncommon.

More than 75% of scars were on the base or lower bole of spruce and hemlock (Table 3). From a timber perspective, wounds on the lower bole affect the most valuable portion of the tree. The upper bole and superficial roots generally received less injury, although 23% of wounds on spruce were on roots. Wounds on roots were significantly smaller in area than wounds on boles. Many of the wounds on the lower bole and roots of residual trees may have been caused by yarding.

Many scars were small, but 26% on spruce and 35% on hemlock were larger than 144 in² (Table 4). Several research studies in areas outside of Alaska (see discussion below) suggest that scars that are larger than one square foot typically become infected by wood-decay fungi and a decay column is initiated.

Most wounds were shallow (Table 5) without deep gouches in wood. Although large shallow wounds will become infected by fungi, internal wood decay may develop somewhat more slowly than in deep wounds.

In addition to wounding injury, two spruce trees were broken off at 20 ft and 30 ft above ground and one spruce was completely uprooted by either wind or logging activities. No hemlock trees were visibly affected in the same manner.

PREVIOUS STUDIES ON INJURED HEMLOCK AND SPRUCE

Numerous studies have been conducted to determine volume loss in western hemlock wounded during logging operations in the Pacific Northwest and British Columbia. Englerth (1942) determined that hemlock wounded by adjacent falling trees in Oregon were frequently infected by wood decay fungi. Fifteen fungi were found to be causing decay in living western hemlock in British Columbia (Buckland et al. 1949) and up to 65% of decay in live trees was associated with wounds. The rate of decay advancement was independent of the growth rate of infected trees in this study. In a cull study of old-growth trees in southeast Alaska, Kimmy (1956) determined that scars on the main bole below the merchantable top were reliable indicators of decay for both hemlock and spruce.

Wright and Isaac (1956) conducted the most comprehensive work on decay in hemlock and spruce wounded by logging. They examined 1,030 hemlock and 126 spruce with scars on 13 sites in Oregon and Washington. Their stated objective was, "to plan cuttings and modify logging practices... foresters and timber operators need to know the probability of occurrence and rate of penetration of decay following

logging injury." Heterbasidion annosum (Fr.) Bref. was the most common cause of decay in scarred hemlock, but in Sitka spruce Fomitopsis pinicola (Schwartz:Fr) Karst. and three other fungi were more common. Decay began more slowly in spruce, but once decay was established, it spread more quickly. The most important dependent variables for volume of decay in multiple regression were scar size and scar age. Most scars studied were less than 20 years old.

Shea (1960) determined that wounding on hemlock and spruce in one 90-year old stand in Washington was concentrated on lower boles or roots and probably resulted from skidding. H. annosum caused most of the decay in scarred hemlock. Over 80% of decay volume in wounded hemlock was attributed to H. annosum in another study in Washington (Hunt and Krueger 1962) where volume loss was particularly severe in wounds on the lower boles.

Decay was studied in over 200 scars in hemlock in British Columbia by Wallis et al. (1971). Seventy-two percent of scarred hemlock were infected by decay fungi and decay was extensive in all trees with old scars. Large scars (larger than 1 ft²) were more likely (80%) to have associated wood decay than smaller scars (42%). H. annosum was responsible for 45% of the number of infected wounds and 60% of the total volume of decay. Etheridge (1973) discussed the biology, host range, and damage by the more important wood decay fungi in British Columbia; H. annosum and F. pinicola were responsible for much of the loss. The latter fungus was a problem in live trees only on the coastal zone of that region and it only attacks dead trees in the interior of B.C. Wallis and Morrison (1975) also found that larger (especially wider) scars were associated with more decay of hemlock in B.C. Their studies were restricted to scars less than 25 years old. Morrison (1979) reported that scars larger than 9dm² (roughly 1 ft²) have a greater than 50% probability of being colonized by H. annosum. Once colonized, this fungus spread rapidly into roots and up the bole, causing annual loss of an average of 0.75% of the gross volume to injured trees.

Pratt (1979a,b) described patterns of stain and decay and associated loss of structural integrity of wood by H. annosum in Sitka spruce planted in Great Britain. Decay progress up boles at a rate of 5-7 cm/yr (2-3 in/yr). Incidence of decay did not vary with soil type or climatic area.

Goheen et al. (1980) studied decay in young-growth hemlock in Oregon and Washington. Some 87% of decay was associated with scars, mostly caused by H. annosum, Armillaria sp., and Haematostereum sanguinolentum. Mortality by any of these fungi was rare. Robbins (1984) stated that H. annosum causes mortality in pine in the eastern United States, but that mortality by this fungus in the western US is uncommon.

Although research has been conducted on injury to hemlock and spruce in areas outside of Alaska, research on wounding of these species is needed in southeast Alaska to determine: 1) the probability of decay being initiated in wounds of different size and location on spruce and

hemlock trees and 2) the rate of development of internal wood decay in wounded trees. Regional differences in environment and behavior of the decay fungi (Hunt and Kruger 1962, Wallis et al. 1971, Etheridge 1973, Morrison et al. 1986) preclude the use of data collected during earlier studies from British Columbia and the Pacific Northwest. In addition, nearly all previous studies have focused on wounds that are less than 25 years old. Trees injured during commercial thinning, wildlife-habitat thinnings, or partial cutting in southeast Alaska may remain for much more than 25 years before being harvested. Research on this topic has been initiated; results will be available in several years.

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Table 1. Wounding by site (combining all 3 treatments) of Sitka spruce and western hemlock remaining after experimental commercial thinning on Prince of Wales Island, Alaska.

<u>Site</u>	<u>Spruce</u>		<u>Hemlock</u>	
	<u>n</u>	<u>Wounded (%)</u>	<u>n</u>	<u>Wounded (%)</u>
Gravelly Creek	33	55	4	50
Naukati	75	68	69	32
Shaheen	<u>79</u>	<u>58</u>	<u>26</u>	<u>35</u>
All sites:	187	61	99	33

Table 2. Wounding by thinning treatment (combining all 3 sites) of Sitka spruce and western hemlock remaining after experimental commercial thinning on Prince of Wales Island, Alaska.

<u>Treatment</u>	<u>Spruce</u>		<u>Hemlock</u>	
	<u>n</u>	<u>Wounded (%)</u>	<u>n</u>	<u>Wounded (%)</u>
20' corridor	39	69	37	24
30' corridor	35	57	20	50
Thinning	<u>113</u>	<u>60</u>	<u>42</u>	<u>33</u>
All treatments:	187	61	99	33

Table 3. Wound location on bole or roots of Sitka spruce and western hemlock remaining after experimental commercial thinning on 3 sites on Prince of Wales Island, Alaska.

<u>Wound location</u>	<u>Spruce Wounds</u>		<u>Hemlock Wounds</u>	
	<u>n</u>	<u>(%)</u>	<u>n</u>	<u>(%)</u>
Upper bole (>16ft)	24	10	3	6
Lower bole (3-16ft)	99	42	19	37
Base of bole (<3ft)	60	25	23	45
Roots	<u>54</u>	<u>23</u>	<u>6</u>	<u>12</u>
Total wounds:	237	100	51	100

Table 4. Size of wounds on Sitka spruce and western hemlock trees remaining after experimental commercial thinning on 3 sites on Prince of Wales Island, Alaska.

<u>Scar size</u>	<u>Spruce Wounds</u>		<u>Hemlock Wounds</u>	
	<u>n</u>	<u>(%)</u>	<u>n</u>	<u>(%)</u>
Small (<36 in ²)	76	33	16	31
Medium (39-144 in ²)	99	42	17	33
Large (>144 in ²)	<u>61</u>	<u>26</u>	<u>18</u>	<u>35</u>
Total wounds:	236	100	51	100

Table 5. Depth of wounds (shallow--only bark removed to cambium or deep--bark and part of sapwood removed) on Sitka spruce and western hemlock remaining after experimental commercial thinning on 3 sites on Prince of Wales Island, Alaska.

<u>Wound depth</u>	<u>Spruce wounds</u>		<u>Hemlock wounds</u>	
	<u>n</u>	<u>(%)</u>	<u>n</u>	<u>(%)</u>
Shallow	214	90	45	88
Deep	<u>23</u>	<u>10</u>	<u>6</u>	<u>12</u>
Total wounds:	237	100	51	100

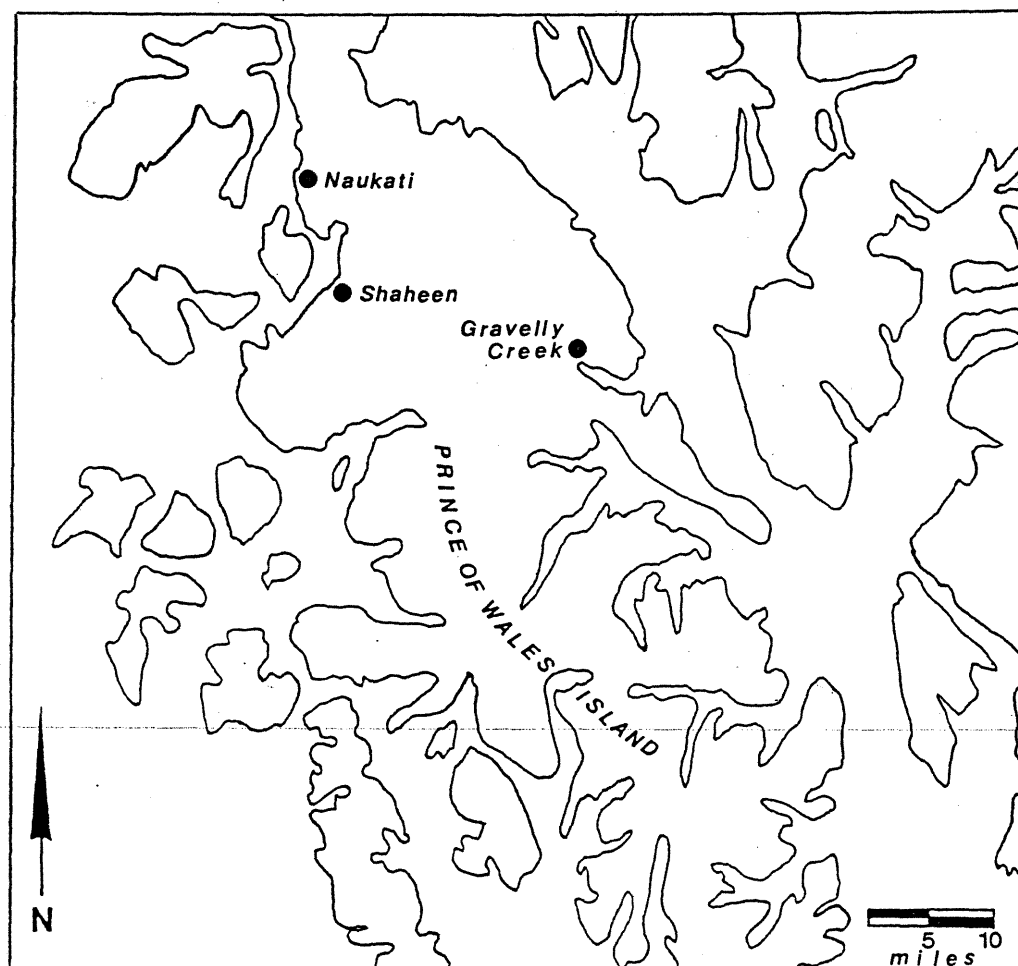


Figure 1. Location of three study sites on Prince of Wales Island in southeast Alaska.